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Boat Electrofishing as a Technique for Sampling Paddlefish

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Abstract.—We used electrofishing and gill netting to sample paddlefish *Polyodon spathula* in the Alabama River drainage during the 1992–1993 spawning migrations. Electrofishing was effective for collecting adults in riverine habitats as well as juveniles in shallow lacustrine areas. Gill netting did not cause immediate mortality, whereas electrofishing was responsible for an overall immediate mortality of 10%. Across sites, paddlefish collected by electrofishing were smaller than those collected by gill netting. In standardized sampling, electrofishing collections yielded a catch per unit effort more than twice that of collections by gill netting. These results provide a benchmark for a sampling technique rarely used with paddlefish and not previously published. Our observations suggest that boat-mounted electrofishing can provide a viable alternative technique for sampling this species, particularly when factors such as excessive current speed and an abundance of submerged timber may preclude the use of other gear.

Many riverine fish species inhabit high-velocity habitats during at least some portion of their life. Such riverine habitats are occupied by paddlefish *Polyodon spathula* during reproduction (Purkett 1961; Russell 1986). Historically, paddlefish have been sampled in riverine and lacustrine habitats with gill nets, otter trawls, snagging, and 2.2-km commercial seines (Coker 1923; Reed et al. 1992). Electrofishing has been used infrequently to sample paddlefish, and its effect and efficiency in sampling this species have not been reported. Biologists in Montana used boat electrofishing as a qualitative technique to locate paddlefish in the Yellowstone River for assessment of distribution, but they did not report using the technique to capture this species (Stewart 1992). Although electrofishing was one of several techniques used to sample paddlefish in riverine stretches of the Missouri River, no results were reported (Rosen et al. 1982). In published literature, only references to anecdotal reports of excessive mortality as a result of electrofishing have been cited to conclude that this technique should not be used (Snyder 1995). Because published data are not available on effects of electrofishing on immediate mortality in paddlefish, we sought to quantify the relationship. Here we report observations on electrofishing effects on the fish, the size structure of the catch, and efficiency of boat mounted electrofishing gear and assess the technique as a way to collect paddlefish in the Mobile River drainage in Alabama.

Methods

Sampling.—We sampled paddlefish during their upstream spawning migrations in two tributaries of the Alabama River: the unregulated Cahaba River, draining into Millers Ferry Reservoir, and the regulated Tallapoosa River, draining into Jones Bluff Reservoir. Sampling was conducted once per week during January–June 1992 and November 1992 to June 1993 by using boat electrofishing gear and 45.7 × 3.6-m gill nets of 127-mm-bar mesh. In both study rivers we fished with gill nets for 3-h periods, removing fish as they were caught.

We electrofished with a boat-mounted Smith-Root type VI-A variable voltage pulsator powered by a 5,000-W AC generator. Sampling was typically conducted at 720–1,020-V DC (depending on water conductivity) pulsed at 4.0–6.0 A. Electrofishing stations were established to sample shoreline and main-channel migrations; each designated station was sampled for a 30-min period. Shoreline sampling was conducted 3–4.5 m from the bank and proceeded with the river current for about 600 s and a distance of 500 m. Main-channel sampling followed a zigzag pattern through the center of the channel between shoreline stations for 600 s, proceeding with the current. Depths at electrofishing stations ranged 1–9 m.

All sampling trips but one were conducted during daylight hours. To consider the capture efficiency of sampling by gill netting and by electrofishing, we standardized effort into 30-min effort intervals. For example, a 3-h gill net set equaled six effort intervals, and an electrofishing sample of four 30-min periods equaled four effort intervals. Crew size was typically maintained at one netter or net tender and one driver; in most instances the same personnel were used during a given field season, minimizing variation due to personnel for comparison of catch and catch per

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TABLE 1.—Number of paddlefish collected (N), total effort, catch per unit effort (CPUE), and mortality from electrofishing and gill netting on both study rivers during 1992 and 1993.

Study river and sampling method	Year	N	Total effort (30-min intervals)	CPUE	Mortality (%)
Tallapoosa					
Electrofishing	1992	180	77.4	2.32	11.7
	1993	214	74.0	2.89	7.5
Gill netting	1992	167	180.0	0.93	0
	1993	173	120.0	1.44	0
Cahaba					
Electrofishing	1992	35	28.5	1.23	20.0
	1993	58	23.1	2.51	5.2
Gill netting	1992	24	82.0	0.29	0
	1993	44	97.7	0.45	0

unit effort (CPUE) between gears, rivers, and years.

Evaluation of immediate, gear-induced mortality was assessed visually on site. Estimates of delayed mortality associated with gears were not made.

Study areas.—In the Cahaba River, we sampled at a fixed station with two gill nets positioned across the river, overlapped upstream and downstream by four electrofishing stations, all within a 10-km reach. Sampling in the Tallapoosa River was conducted at two sites: a fixed gill-net station at a former gravel operation located 34.0 km upstream of the confluence with the Alabama River and an upstream site containing four fixed electrofishing stations in a 10-km reach established 70 km from the river's confluence with the Alabama River. Conductivity within the study reaches of the Cahaba and Tallapoosa rivers averaged 146 and 44 μS/cm, respectively (Scheidegger 1990). Additionally, we made annual trips to sample two oxbow lakes (Brickyard and Silver lakes, Baldwin County, Alabama) on the Alabama River floodplain near Tensaw, Alabama, with electrofishing (these lakes were too shallow to permit sampling with gill nets). Immediate mortality was not assessed at the oxbow lakes because all fish were removed for aging.

Results

Gear-Induced Mortality

Electrofishing gear resulted in occasional mortality. In each instance a separated notochord was observed, which paralyzed fish posterior to the location of separation, thus, rendering them unable to swim and causing them to float on the water surface. Electrofishing in the Cahaba River led to 7 deaths (20.0%) of 35 individuals collected in 1992 and 3 deaths (5.2%) of 58 individuals collected in 1993 (Table 1). Of 180 individuals collected through electrofishing on the Tallapoosa River during 1992, 21 fish (11.7%) died, whereas electrofishing in 1993 resulted in 16 deaths (7.5%) among 214 individuals collected. The mortality ratio of males to females in both rivers combined during 1992–1993 was 14.7:1, which contrasts with a ratio of 1.7:1 for all paddlefish collected. No fish died immediately as a result of gill netting.

TABLE 2.—Mean (±SD) length and weight (with ranges in parentheses) of paddlefish sampled with electrofishing gear and gill nets in the Alabama River drainage. Samples collected in the Tallapoosa River, Cahaba River, and Brickyard Lake are combined for 1992 and 1993, whereas samples from Silver Lake were collected during 1993. Sexes are combined for all sites; length (BL) is anterior edge of eye to tail fork.

Location	N	Length (mm, BL)	Weight (kg)
	Electrofishing		
Tallapoosa River	413	931 ± 65 (612–1,110)	11.9 ± 3.0 (2.8–22.5)
Cahaba River	97	867 ± 71 (592–1,008)	10.0 ± 3.0 (2.1–17.3)
Brickyard Lake	21	544 ± 125 (385–881)	2.5 ± 2.0 (0.8–8.3)
Silver Lake	19	621 ± 125 (399–802)	3.8 ± 2.2 (0.8–7.8)
	Gill netting		
Tallapoosa River	336	931 ± 57 (764–1,105)	12.4 ± 2.8 (6.6–23.8)
Cahaba River	64	899 ± 50 (807–1,028)	11.1 ± 3.0 (6.0–19.5)

Analyses of Catch

Both length (F = 9.17, df = 159, P = 0.003) and weight (F = 4.36, df = 159, P = 0.04) of paddlefish collected with electrofishing gear in the Cahaba River were significantly lower than for paddlefish collected with gill nets. In the Tallapoosa River, paddlefish collected by electrofishing weighed less than fish collected by gill netting (F = 4.8, df = 747, P = 0.03), although fish length did not differ significantly between gear types (F = 0.01, df = 746, P = 0.93). Electrofishing in Brickyard and Silver lakes, areas frequented by nonmigratory juvenile paddlefish, resulted in collection of the shortest and lightest fish during the study. However, electrofishing in the Cahaba and Tallapoosa rivers yielded the shortest and lightest adult paddlefish, whereas gill netting yielded the longest and heaviest (Table 2).

Catch per Unit Effort

Paddlefish were present at the Cahaba River study site during 2 February–28 April 1992 and 18 January–3 May 1993. During both years, electrofishing yielded more individuals than did gill netting and required only 24–35% of the effort (Table 1). Paddlefish were present at the two Tallapoosa River study sites during 16 January to 2 June 1992 and 25 November 1992 to 26 May 1993. As in the Cahaba River, electrofishing yielded a much higher CPUE than did gill netting. In both rivers and during both years, electrofishing yielded more individuals than did gill netting, although the number of fish taken within a given river was often similar between gear types.

Discussion

Our observations indicate that electrofishing provided a viable technique for sampling paddlefish of all sizes in lentic and lotic habitats of the Alabama River system, although some mortality did occur due to paralysis. This problem is often cited by biologists as a reason for not using electrofishing for sampling paddlefish (V. Pitman, Texas Parks and Wildlife Department, personal communication; B. Reed, Louisiana Department of Wildlife and Fisheries, personal communication). Although the extent of injury or mortality resulting from electrofishing for paddlefish has not been reported in the published literature, anecdotal observations have resulted in a dogma biased against using this sampling technique (Snyder 1995).

The tendency of paddlefish to occupy deep water in reservoirs and the tail races below dams has resulted in the predominance of overnight gill-net sets as the standard sampling approach (Ambler 1987; Reed et al. 1992; Boone and Timmons 1995). However, although no paddlefish died immediately after capture with gill nets in our study, mortality may not always be preventable. For example, gill nets set overnight may result in mortality as high as 18% (Filipek 1990), particularly if mesh sizes trap the fish's mouth shut, thus preventing ram-gill ventilation and leading to eventual suffocation. The short duration of net sets in our study (3 hours) together with continual monitoring of the nets and the use of a large mesh size probably combined to prevent immediate mortality in our gill-net samples. Finally, as in most fishery work, we required a subsample of paddlefish for age and growth information; thus, the 10% overall immediate mortality incurred during electrofishing in the two rivers was not inconsistent with our study objectives. If sacrifice of fish is not required for completion of a study's objectives, high levels of immediate mortality due to electrofishing would probably not be acceptable.

Because we quantified immediate mortality but not delayed mortality, some fish collected with both gears might have experienced delayed mortality. However, fish collected by electrofishing often appeared to be in better condition upon release than those taken through gill netting. Paddlefish collected via gill netting were often under considerable stress. Entanglement in monofilament nets often resulted in fin lacerations, skin abrasions, and subsequent loss of the protective dermal slime layer. In addition, adult paddlefish collected with electrofishing during 1993–1995 were used for educational purposes at the Auburn University Fisheries Research Station, where they have been artificially spawned repeatedly with high success (R. Phelps, Auburn University, personal communication). Given such success and collecting efficiency, hatchery managers working with this species might want to consider electrofishing to collect broodfish.

More males than females died from electrofishing, relative to the sex ratio of all fish that were collected. This difference might have resulted from morphological differences (average size of males was smaller than females in both rivers during both years), physiological differences, or possibly behavioral adaptations that cause sexes to be positioned differently in the water column and, thus, differently within the electrical field. We observed that males, unlike females, were often not immediately immobilized by electrofishing but, rather turned in tight circles repeatedly until we could move the boat such that we positioned individuals closer to the anodes.

Although the numbers of individuals collected with the two gears were similar in both rivers, electrofishing CPUE was higher, suggesting that electrofishing was more efficient than gill netting in the Alabama River system. We purposefully used these types of gear in locations and habitats to which the gears were best suited; and hence, we believe that differences in their sampling efficiencies are real. Thus, CPUE values represent the efficiency of the respective gear in locations that maximized our ability to capture paddlefish. Further, analysis of the catch showed collection by gill nets was size-biased, indicating the importance of sampling the entire size–age structure of a population with multiple mesh sizes to eliminate potential bias between comparisons of gears.

These results illustrate that boat electrofishing provides a viable alternative method for sampling juvenile and adult paddlefish in fast-water riverine habitats as well as in shallow lacustrine waters. Although 10% gear-induced mortality may appear to be high, we note that the electrofishing protocol for this study was no different than that followed for main-channel electrofishing surveys of the entire fish community. Therefore, electrofishing-induced paddlefish mortality may be reduced through research directed toward the impacts of variations in electrofishing parameters (e.g., pulse width, pulse frequency, pulse trains, voltage, amperage; as suggested for other species by Snyder 1995).

Electrofishing surveys of paddlefish spawning migrations can provide data on population dynamics that is otherwise unattainable because of the problems associated with drifting or fixed gill nets in such riverine habitats (e.g., fast water, entanglement on roots or trees, and irregular bottom contour), and can thus provide information complimentary to studies conducted with gill netting in reservoirs. Our choice of gears was dictated by overall study objectives, as well as by inherent limitations of the two techniques under certain situations. Studies designed specifically to compare the efficiencies of electrofishing and gill netting for paddlefish would benefit from sampling with both types of gear in all habitats at a given locality and, whenever possible, with these data providing a benchmark for comparison. However, the application of this collection technique will only be fully understood when investigated in other portions of the species range.

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